CLAIMS

What is claimed is:

1. A method for prestack time migration, including velocity calibration and trend fitting ("iDEPTHing") before curved-ray prestack time migration, comprising:

   a. editing seismic velocities, including at least one of honoring geologic trends existing in a survey area, using envelopes of vertical trends based on rock properties and using computed envelopes;

   b. computing lateral trends of RMS velocities derived from seismic data by geostatistical variogram modeling;

   c. preparing scale factors from well (hard) data and seismic (soft) data wherein the well (hard) data include at least one of checkshot data and up-scaled and bulk-shifted sonic logs;

   d. calibrating RMS velocities, including applying interpolated scale factors to RMS velocities wherein the interpolation is a function of the lateral trends; and

   e. curved-ray prestack time migration using interpolated calibrated RMS velocities, wherein the interpolation is a function of the lateral trends.

2. A method for velocity calibration and trend fitting ("iDEPTHing") before prestack depth migration, comprising:

   a. constructing a geologically plausible velocity model from seismic data for subsequent prestack depth migration;

   b. computing variogram modeling of interval velocities;

   c. calibrating interval velocities from the velocity model with hard well data and trend fitting the calibrated velocities using the variogram modeling ("iDEPTHing");

   d. interpreting prestack time migration results;

   e. verifying well marker ties;

   f. updating key horizons based on the verifying;

   g. repeating steps a.-f at least once; and

   h. prestack depth migrating seismic data using the calibrated, trend fitted velocity model.

3. The method of claim 1 wherein editing of seismic velocity data, includes weighing, and further includes converting seismic velocities to interval velocities using Dix equation and to average velocities wherein interval velocities are defined at the center of the layers; and at least one of:

    a. computing envelope interval functions by specifying upper and lower limits based on geologic constraints and deleting and/or down weighting erratic functions of picks, lying outside of envelope functions; and

    b. re-sampling and applying median and damped-least-square filters on RMS velocity domain.

4. The method of claim 1 that includes calibrating seismic velocities using at least one key controlling stratigraphic horizon such that said stratigraphic horizon(s) provides conforming surfaces for velocity calibration.

5. The method of claim 1 that includes

    deriving correction scale factors between well (hard) data and seismic (soft) data; and interpolating scale factors by geostatistical Kriging, where scale factors are computed by dividing checkshot RMS velocities with seismic RMS velocities at well locations; and computing calibrated velocities by multiplying scale factors.

6. The method of claim 1 that includes computing lateral trends of RMS velocities, consistent with geologic trends, by

    a. computing a variogram model of seismic RMS velocities; and

    b. adjusting the model to take into account at least one of geologic trends and velocity trends derived from well (hard) data; and that further include interpolating calibrated seismic RMS velocities by Kriging on a stratigraphic grid for prestack time migration using the adjusted variogram model.

7. The method of claim 2 that includes calibrating seismic interval velocities using stratigraphic horizons by

    a. selecting at least one stratigraphic horizon, which will provide at least one conforming surface for interpolating interval velocities;

    b. interpreting and updating stratigraphic horizons after curved-ray prestack time migration for use with prestack depth migration; and

       c. calibrating at least one of interval or average velocities using key controlling stratigraphic horizons.

8. The method of claim 2 wherein computing variogram modeling of interval velocities includes:

       a. adjusting the modeling with at least one of geologic trends and velocity trends from well (hard) data;

       b. building a conforming stratigraphic unit using at least two updated stratigraphic   surfaces; and

       c. interpolating seismic interval velocities on a new stratigraphic grid for pre-stack depth migration.

9. The method of claim 1 wherein the well (hard) data includes a plurality of wells of checkshot data.

10. The method of claim 1 that includes viewing at least one of geological maps, faults, geo-pressure zones, geologic markers and salt intrusion on an interactive workstation.

11. The method of claim 1 that includes editing using envelopes and computing regional envelopes for a large survey area with hundreds of lease blocks.

12. The method of claim 4 that includes using at least one horizon controlling sedimentation style due to compaction.

13. The method of claim 1 wherein preparing scale factors includes at least one of deviated checkshot data and checkshot data from adjacent blocks in the well (hard) data.

14. The method of claim 1 that includes calibrating average velocities derived from seismic data, including applying interpolated scale factors to the average velocities, and interpolating the calibrated seismic average velocities for time-to-depth conversion and depth interpretation.

15. The method of claim 1 that includes interpolating scale factors by geostatistical Kriging, wherein scale factors are computed by dividing at least one checkshot and sonic interval (or average) velocities with seismic interval (or average) velocities at well locations; and computing calibrated velocities by multiplying scale factors.

16. The method of claim 1 wherein checkshot data includes at least one of deviated checkshot data and checkshot data from adjacent blocks.

17. The method of claim 2 wherein calibrating interval velocities includes applying to the interval velocities an interpolated scale factor, the scale factor being a function of well (hard) data and seismic (soft) data and that includes adding a scale factor between true depth and migrated depth into the scale factor computed from hard and soft data.

18. The method of claim 1 that includes using at least one of salt entry points and proximity survey for calibration.

19. The method of claim 9 wherein sonic velocities are calibrated with checkshot data.

20. The method of claim 1 including adjusting lateral trends from seismic (soft) data with lateral trend from well (hard) data.

21. The method of claim 1 wherein the well (hard) data includes upscaled and bulk-shifted sonic logs, and that includes upscaling sonic logs by integrating transit times at every 100 feet or by fitting a polynomial function and bulk shifting to fit the vertical trends wherein the shift caused due to missing data between the surface and logging depth.

22. A velocity model for use in time migration of 3D prestack seismic data, comprising:

geostatistically interpolated, calibrated velocity function values associated with 3D prestack seismic data trace locations, the geostatistically interpolated, calibrated velocity function values being a function of the application of geostatistical interpolation to calibrated velocity functions, the calibrated velocity functions being the product of a combination of the geostatistical interpolation of at least one scale factor with a seismic (soft data) velocity functions derived from 3D prestack seismic (soft) data, and at least one scale factor being a function of a well (hard) data source; and

wherein the geostatistical interpolations are a function of lateral velocity trends developed from the 3D prestack seismic data.

23. The velocity model of claim 22, wherein the soft data (seismic) velocity functions have been edited.

24. The velocity model of claim 22 wherein the geostatistical interpolations use a stratigraphic grid based on at least one established stratigraphic horizon.

25. A method for developing a velocity model for use in migrating seismic data, comprising:

from 3D prestack seismic data, developing soft data (seismic) velocity functions for select locations and developing a variogram model of lateral velocity trends;

from a plurality of hard data sources, developing a set of scale factors for each source, each scale factor relating a hard data velocity function derived from the source and a seismic (soft data) velocity function;

geostatistically interpolating the scale factors and applying the interpolated scale factors to seismic (soft data) velocity functions to create calibrated velocity functions;

geostatistically interpolating the calibrated velocity function to trace locations; and

wherein the geostatistical interpolations are a function of the variogram model.

26. The method of claim 25 that includes editing the seismic (soft data) velocity functions.

27. The method of claim 25 wherein the geostatistical interpolations utilize a stratigraphic grid based on at least one established stratigraphic horizon.

28. A method for enhanced time migration of 3D prestack seismic data, comprising:

generating soft data (seismic) velocity functions and lateral velocity trends from at least a portion of 3D prestack seismic (soft) data;

computing well (hard data) velocity functions from at least two sources of well (hard) data;

creating at least two sets of scale factors, each set associated with a source of well (hard) data, each scale factor a function of a well (hard) data velocity function and a seismic (soft data) velocity function;

applying interpolated scale factors to seismic (soft data) velocity functions to create calibrated velocity functions, and interpolating calibrated velocity functions to trace locations, the interpolation of scale factors and · calibrated velocity functions being a function of the lateral velocity trends; and

applying curved ray time migration to 3D prestack seismic data using the interpolated calibrated velocity functions.

29. The method of claim 28 wherein the seismic (soft data) velocity functions are edited.

30. The method of claim 28 wherein the interpolations utilize a stratigraphic grid incorporating at least one established stratigraphic horizon.

31. The method of claim 28 wherein the lateral velocity trends including variogram modeling and the interpolation includes Kriging.

32. The method of claim 28 that includes editing the hard data velocity functions.

33. An improved method for migrating 3D prestack seismic data comprising:

developing a calibrated, trend fitted RMS velocity model from 3D prestack seismic data and a plurality of hard data sources;

applying curved-ray time migration to the 3D prestack seismic data using the velocity model;

developing a calibrated trend fitted interval velocity model, incorporating at least one horizon derived from the previously migrated data; and

depth migrating the 3D prestack seismic data using the calibrated, trend fitted interval velocity model.

34. The method of claim 33 that includes iterating over the steps of developing the interval velocity model and depth migration until a satisfactory convergence is established.

35. The model of claim 22 wherein the calibrated velocity function is the product of the combination of the geostatistical interpolation of at least two scale factors, each scale factor being a function of a separate well (hard) data source.